

PlayStation Move® and conventional handheld videogame controllers **43** such as the DualShock 4®; portable **10** entertainment devices **44** such as the PlayStation Portable® and PlayStation Vita®; a keyboard **45** and/or a mouse **46**; a media controller **47**, for example in the form of a remote control; and a headset **48**. Other peripheral devices may similarly be considered such as a microphone, speakers, mobile phone, printer, or a 3D printer (not shown).

[0025] The GPU **20B**, optionally in conjunction with the CPU **20A**, generates video images and audio for output via the AV output **39**. Optionally the audio may be generated in conjunction with or instead by an audio processor (not shown).

[0026] The video and optionally the audio may be presented to a television **51**. Where supported by the television, the video may be stereoscopic. The audio may be presented to a home cinema system **52** in one of a number of formats such as stereo, 5.1 surround sound or 7.1 surround sound. Video and audio may likewise be presented to a head mounted display unit **53** worn by a user **60**.

[0027] In operation, the entertainment device defaults to an operating system such as a variant of FreeBSD 9.0. The operating system may run on the CPU **20A**, the auxiliary processor **38**, or a mixture of the two.

[0028] The video game playing device illustrated schematically in FIG. 1 is an example of a video game playing device that may be used in accordance with the present disclosure. In FIG. 1, an additional peripheral device, in the form of a banana **49**, is also shown. The ways in which such an object may be used as a controller will be apparent from the embodiments described below.

[0029] As mentioned previously, motion controllers are one means through which a player may provide an input to a video game playing device. Typically, motion controllers incorporate an internal sensor (e.g. gyroscope, accelerometer) or a light source to enable the position of the controller to be tracked. In the former example, the motion controller usually transmits an indication of its position and orientation to a video game playing device, which updates the actions of a virtual character accordingly. In the latter example, the light source is usually tracked by a video camera, which detects the location of the lights in the video images and determines corresponding user inputs based on changes in the locations and/or separation of the light sources, e.g. via constellation tracking. Whilst motion controllers such as these may allow for accurate tracking of a player's movements, a player may find the cost of such devices prohibitive, or that their motion controller has insufficient power and therefore cannot be used immediately. A system for alleviating these problems will now be described in relation to FIG. 2. The video game playing device described in relation to FIG. 1 may correspond to or form part of such a system.

[0030] FIG. 2 shows schematically an example of a system **200** for generating user inputs for a video game. The system **200** comprises an input unit **201**, object detector **202**, object pose detector **203** and user input generator **204**. In FIG. 2, images are shown as an input, and video game inputs (in this case, corresponding to button presses) shown as an output.

[0031] The input unit **201** is operable to obtain images of a non-luminous passive object being held by a user. The object may correspond to an inanimate object that is being held by a user so as to use the object as a video games controller. The object is said to be non-luminous in the sense

that it is not emitting light, or at least not for the purposes of enabling tracking of the object. In some examples, the object may not be capable of producing light, only reflecting light from an external light source. The non-luminous object may correspond to an everyday item such as e.g. a banana, orange, mug, pen, glass, etc. In some examples, the non-luminous object does not comprise any internal positional sensors. In other examples, the object may comprise positional sensors, but these are not used for performing tracking of the position and orientation of the device, at least not for the purposes of generating user inputs for a video game.

[0032] The object is said to be passive in that it is not actively generating or emitting data (e.g. light, radio signals, etc.) so as to facilitate tracking of the object. In the present disclosure, references to a 'non-luminous object' will be understood as meaning a passive, non-luminous object as described above.

[0033] The input unit **201** may be configured to obtain images of the non-luminous object from a video camera that is arranged to capture images of the user holding the non-luminous object. For example, the input unit **201** may correspond to a communication interface of a video game playing device (such as that described in relation to FIG. 1) that is configured to receive video images of the user from a video camera via a wired or wireless connection. The images may be received via, the AV In **31**, Ethernet **32**, Bluetooth **33**, Wi-Fi **34** and USB **35** ports described previously in relation to FIG. 1, or indeed, any suitable means. The video camera may correspond to e.g. a peripheral device, such as e.g. the PS Camera™. The input unit may comprise e.g. a video buffer that stores video frames received from the video camera, prior to subsequent processing (as described below). Generally, the video images correspond to video images captured of the user in real or near-real time, which are subsequently used to control the operation of the video game playing device in real or near-real time (with any delays arising from e.g. the propagation and processing of the images).

[0034] FIG. 3 shows schematically an example of a video image **300** in which a user is holding a banana **302** (an example of a non-luminous object) with their hands **304**. The video image **300** is an example of an image that may be obtained by (or at) the input unit **201**. Returning to FIG. 2, the input unit **201** is shown as providing an input to the object detector **202**. The object detector **202** is configured to detect the non-luminous object in the obtained images. The object detector **202** is configured to detect an area in the image corresponding to the non-luminous object based on the pixels corresponding to the object and not based on a physical identifier that has been added to the object. It is known in the art, for example, that QR code stickers can be added to objects so as to allow those objects to be detected and identified. However, in the present disclosure, it is the pixels in the images corresponding to the object that are identified, e.g. via segmentation.

[0035] It will be appreciated that, in some examples, a user may have a non-luminous object in each hand. The generation of video game inputs in such a situation will be discussed later (see section: two object controller).

[0036] It is noted that the term "based on" is used throughout the present disclosure. The skilled person will appreciate that this term can imply "in dependence upon", "in response to" and the like, such that data A being based on data B indicates that a change in data B will lead to a resulting